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November 3, 1999

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Attn: Ms. Katherine H. Landman
Navy Technical Representative
Code 18232

Re: Contract N62470-89-D-4814
Navy CLEAN, District III
Contract Task Order (CTO) 0356
Operable Unit No. 16 (Site 89)
MCB, Camp Lejeune, North Carolina

Dear Ms. Landman:

Baker Environmental, Inc. (Baker) is pleased to submit this letter report for Operable Unit No. 16, Site 89. The sections that follow provide details concerning Site 89, with specific focus on the Defense Reauthorization and Marketing Office (DRMO) area. This letter report has been prepared to summarize previous studies at Site 89 and present a brief description of general trends that we have observed in the data collected to date.

Introduction

Several investigative activities have been completed at Site 89; all confirming the presence of volatile organic compounds (VOCs) in soil and groundwater. This report has been prepared with specific attention given to the area of Site 89 known as the DRMO. Through various investigations, it has become apparent that the DRMO area of Site 89 is the area most affected by VOC contamination.

Further investigation is required to accurately identify the source of VOC contamination at the site, and to determine potential pathways for contaminate migration to Edwards Creek. This letter report was initiated by the detection of a high concentration of 1,1,2,2-tetrachloroethane (PCA) in groundwater samples obtained in April 1999. A concentration of 30,000 µg/L was detected in a groundwater sample collected from monitoring well IR89-MW02. There were no detections of this contaminant at any location within the DRMO before this sampling event. The compound 1,1,2,2-PCA is a human carcinogen, and if ingested at this concentration, would generate cancer risks greater than the acceptable risk range according to USEPA risk assessment models.

The following sections provide a brief history of the DRMO area and describe the investigative activities at Site 89. The material presented below illustrates trends in the data that indicate further investigation is necessary. It is important to note that the text focuses on VOCs, although samples were analyzed for other parameters under some investigations.

Ms. Katherine H. Landman
November 3, 1999
Page 2

History of the DRMO

Prior to 1987, the southern area of the DRMO was used for heavy vehicle storage and maintenance. Base personnel reported heavy use of solvents during that time. The solvents included acetone, trichloroethene (TCE), and methyl ethyl ketone. DRMO operations have been in this location since 1990.

In the early 1990s fuel bladders (mobile storage tanks) were placed on site with the intent that the bladders be shredded and subsequently disposed following their use. The bladders ranged in size from 600 gallons to 20,000 gallons and were used in training exercises for helicopter refueling. Base personnel reported that the bladders were emptied, cleaned with solvents, re-emptied, and capped prior to storage at the DRMO. Acetone was reportedly used, and possibly 1,1,2,2-PCA. The bladders were stored for 3 to 4 years in a pile approximately 75 feet in diameter by 25 feet high. The pile was located west of what is now the oil changing area. This area is shown on Figure 1. A shredder was brought on site and located immediately north of the bladder pile. The bladders were shredded into small cubes and placed into roll-off boxes. During shredding operations liquids were observed escaping from the bladders. These liquids were not contained or removed.

Summary of Previous Investigations

Three previous investigations have been completed at Site 89, including:

- Phase I and II Remedial Investigation (RI) - August 1996 and May 1997
- MCB, Camp Lejeune Monitoring Program - April 1999
- Immediate Response Field Effort - June/July 1999

Phase I and II RI – August 1996 and May 1997

The RI was conducted in two phases; August 1996 and May 1997. The investigation included the collection of soil, groundwater, surface water, and sediment samples. These samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), metals, and pesticides/polychlorinated biphenols (PCBs).

The VOCs detected in soil samples included 1,1,2,2-PCA, 1,2-dichloroethene (DCE), 2-butanone, acetone, benzene, carbon disulfide, tetrachloroethene (PCE), toluene, and TCE. The compounds 2-butanone and carbon disulfide are not known to have been related to previous operations and are therefore assumed to be a result of laboratory contamination and the use of potable water during drilling operations. None of the VOCs exceeded the Region III RBCs for soil; however, several detections of TCE exceeded the screening criteria for transfer of soil contaminants to groundwater. The majority of detections were present in samples collected during the installation of monitoring well clusters IR89-MW01 and IR89-MW03. Both monitoring wells are located within the DRMO area, near existing wash racks.

The groundwater investigation at Site 89 entailed the collection of samples from the surficial and Castle Hayne aquifers. As shown on Table 1, six VOCs were detected in the groundwater samples collected from the select wells at Site 89. They included, 1,1,2,2-PCA, cis-1,2-DCE, trans-1,2-DCE, PCE, TCE, and vinyl chloride (VC). The majority of the detections were from shallow monitoring wells within the DRMO near the existing wash racks.

A total of ten surface water samples were collected from Edwards Creek at Site 89. As provided on Table 2, nine volatile compounds were detected in the surface water samples, including 1,1,2,2-PCA, 1,2-DCE (total), methylene chloride, chloroform, cis-1,2-DCE, trans-1,2-DCE, PCE, TCE, and VC. The sample locations with the highest number of maximum detections were IR89-SW02 and IR89-SW04. These stations are located south and hydraulically downgradient of the DRMO area. Four of the compounds, including 1,1,2,2-PCA, PCE, TCE, and VC were detected at concentrations exceeding Federal Ambient Water Quality Criteria (AWQCs).

Ten sediment samples were collected from five locations in Edwards Creek under the Phase II RI. The samples were collected with a sediment corer at depths of zero to six inches and six to twelve inches below the streambed. Sediment samples were analyzed at a fixed based laboratory and a mobile laboratory. Nine VOCs were detected in the samples. The majority of the detections occurred in the zero to six-inch sample depth. The detected compounds included 1,1,2,2-PCA, 1,1,2-TCA, 1,1-DCE, 1,2-DCE (total), cis-1,2-DCE, trans-1,2-DCE, toluene, TCE, and VC. At present, there are no sediment screening levels for sediment in USEPA Region IV. Sediment samples were not collected during the April 1999 Monitoring Program sampling event, or the June/July immediate response field effort. Because there is not enough data to show trends, the data is not presented on a table.

Monitoring Program – April 1999:

Groundwater samples at Site 89 are collected on a semi-annual basis as part of the base-wide groundwater monitoring program at Camp Lejeune. The first round of sampling for Site 89 under the monitoring program occurred in April 1999. The monitoring program at Site 89 is intended to detect changes in groundwater contaminant concentrations and monitor contaminant migration. In addition, the program provides data used in evaluating natural attenuation processes. Nine groundwater and four surface water samples were obtained during the first round of sampling at Site 89. Each of the samples were analyzed for VOCs. (Note that groundwater samples were also analyzed for natural attenuation parameters; however, these results are not relevant to this discussion and are not in this letter report.)

Of the nine groundwater samples collected at Site 89, five were from within or near the DRMO area (IR89-MW02, IR89-MW03, IR89-MW03IW, IR89-MW04, and IR89-MW04IW). Ten VOCs were detected from these select monitoring wells, including VC, acetone, methylene chloride, 2-butanone, TCE, cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,2,2-PCA, and 1,1,2-TCA. The compounds methylene chloride and 2-butanone are considered laboratory artifacts and not site contaminants. The concentrations in the groundwater samples are compared to relevant standards on Table 1. As shown by the information presented on the table, nearly all of the detected contaminants exceeded Federal Maximum Contaminant Levels (MCLs) and/or North Carolina Water Quality Standards (NCWQS) for groundwater. A detection of 1,1,2,2-PCA at 30,000 µg/L was identified during the April 1999 monitoring effort in the sample obtained from monitoring well IR89-MW02. The compound 1,1,2,2-PCA is a class C (possible human) carcinogen. If the ingestion pathway was evaluated under a drinking water scenario, the detected concentration of PCA would cause extremely high cancer risks. (i.e., Hazard Indices of 7.0×10^{-2} and 3.3×10^{-2} for adults and young children, respectively). These values are above the USEPA acceptable risk range of 1.0×10^{-6} to 1.0×10^{-4} . Possible industrial uses of 1,1,2,2-PCA include the following: nonflammable solvent for fats, oils, waxes, resins, cellulose acetate, rubber, coal, phosphorus, and sulfur; the manufacturing of paint, varnish, and rust removers; soil sterilization, weed killer, and insecticide formulations. The compound 1,1,2,2-PCA is a strong narcotic and poisons the liver.

Eight VOCs were detected in the four surface water samples collected from Edwards Creek as part of the April 1999 monitoring program. These include VC, acetone, methylene chloride, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1,2,2-PCA, and 1,1,2-TCA. Of these contaminants for which there are Federal or State water quality standards, all detections except for one exceeded Federal Ambient Water Quality Standards. The detections for 1,1,2,2-PCA in samples IR89-SW04 and IR89-SW11 also exceeded the applicable NCWQS for surface water. These standards and contaminant detections are presented in Table 2.

Immediate Response Field Effort – June/July 1999:

As described above, an elevated concentration of 1,1,2,2-PCA (30,000 µg/L) was detected in the groundwater sample from shallow monitoring well IR89-MW02 (April 1999 data). Baker informed the LANTDIV Navy Technical Representative (NTR) of this concentration, discussed the significance of the detection, the potential impact to Edwards Creek, and the potential for a continued source of VOCs present at the site.

As a result of this discussion, Baker was requested to perform additional investigative activities at Site 89. An immediate response investigation was completed in June/July of 1999. Activities included the installation of permanent monitoring wells and associated groundwater sampling, the collection of soil samples, and the collection of surface water samples. Attachment A includes several site photographs taken as part of the field investigation. In summary, the following tasks were completed as part of the immediate response effort:

- A groundwater sample was obtained from existing monitoring well IR89-MW02 to verify the detection and magnitude of 1,1,2,2-PCA concentrations within the shallow aquifer.
- Monitoring well IR89-MW08 was installed approximately 200 feet southeast of existing monitoring well IR89-MW02. A groundwater sample was collected to determine if 1,1,2,2-PCA had migrated via the shallow aquifer toward the existing drainage ditch which discharges immediately to Edwards Creek.
- A monitoring well cluster (including one shallow and one intermediate well) was installed directly adjacent to Edwards Creek. The cluster was positioned immediately upstream of the railroad crossing (White Street Extension) to determine if 1,1,2,2-PCA has migrated to Edwards Creek via the shallow or the intermediate aquifer.
- Soil samples were collected during the installation of the shallow monitoring wells. The samples were obtained at interval of 1 to 3 feet (ft) below the ground surface (bgs) and at 3 to 5 ft bgs.
- Surface water samples were obtained from three locations in Edwards Creek. One sample each from upstream and downstream of the railroad crossing (White Street Extension), and one sample approximately 250 feet downstream of the crossing.

During the installation of monitoring wells IR89-MW08 and IR89-MW09, soil samples were collected from the 1-3 foot and 3-5 foot depths. A duplicate analysis was performed for IR89-MW09-02. As illustrated on Figure 2, eight VOCs were detected in the soil samples (including the duplicate). These include: acetone, trans-1,2-DCE, cis-1,2-DCE, TCE, 1,1,2-TCA, PCE, 1,1,2,2-PCA, and xylenes (total). The 1-3 foot sample collected from IR89-MW09 had the highest detection of 1,1,2,2-PCA at 29,000 µg/kg. The concentration of 1,1,2,2-PCA in the 3-5 foot sample from IR89-MW09 was 27,000 µg/kg. This sample also had the highest concentration of TCE at 2,000 µg/kg. The concentrations for each contaminant were compared to the USEPA Region III risk-based concentrations (RBCs) for residential and industrial scenarios, and for the

transfer of contaminants from soil to groundwater. Concentrations of 1,1,2-TCA, PCE, and 1,2,2,2-PCA exceeded the applicable industrial and/or residential RBCs. All of the detected concentrations of 1,1,2-TCA, PCE, 1,1,2,2-PCA, and TCE exceeded the screening level for being transferred from soil to groundwater. The exceedences are presented in Table 3. The calculated USEPA soil to groundwater transfer soil screening levels are presented on Table 4.

The analytical results for the groundwater and surface water samples are presented on Figure 3. Four groundwater samples were collected at Site 89 from monitoring wells IR89-MW02, IR89-MW08, IR89-MW09, and IR89-MW09IW. A duplicate analysis was performed for the sample obtained from IR89-MW02. As can be seen on the figure, significant detections of VOCs were noted in the samples obtained from the monitoring wells. Nine VOCs were detected, including VC, acetone, cis-1,2-DCE, trans-1,2-DCE, 1,1,2-TCA, 1,1,2,2-PCA, TCE, benzene, and PCE. Although many of the compounds were detected at low concentrations, TCE detections exceeded the Federal MCL and the NCWQS at every well, with the highest concentration being 59,000 µg/L from IR89-MW09. This monitoring well is located at the extreme southern point of the site adjacent to Edwards Creek. High concentrations of 1,1,2,2-PCA were detected in the sample and the duplicate sample collected from IR89-MW02. The detected concentrations were 46,000 µg/L and 47,000 µg/L for the sample and duplicate sample, respectively. If groundwater were ingested at a concentration of 47,000 µg/L of 1,1,2,2-PCA, a potential cancer risk of 1.1×10^{-1} for adults and 5.1×10^{-2} for children would result. There are no State or Federal groundwater standards for 1,1,2,2-PCA. Overall, at least one or more detections of the following contaminants exceeded the NCWQS, Federal MCLs, or both: VC, cis-1,2-DCE, trans-1,2-DCE, 1,1,2-TCA, TCE, and PCE. Exceedences of standards for samples collected from IR89-MW02 are shown on Table 1. There is no established MCL or NCWQS for 1,1,2,2-PCA.

Three surface water samples were collected from Edwards Creek as part of the immediate response field effort. As depicted on Figure 3, each of the surface water samples identified VOCs, which is consistent with previous sampling efforts in the stream. Eleven VOCs were detected, including VC, acetone, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, 1,1,2,2-PCA, TCE, 1,1,2-TCA, benzene, toluene, and chlorobenzene. Of the contaminants that have a State or Federal standard, all exceeded Federal AWQS except for the detections of toluene and chlorobenzene. Detections of 1,1,2,2-PCA and TCE also exceeded the NCWQS. These exceedences are provided on Table 2.

Data Trends and Indications

An evaluation of the VOC detections in groundwater indicates that two shallow monitoring wells in particular have had an increase in concentrations of contaminants. The concentrations of TCE, cis-1,2-DCE, trans-1,2-DCE, and 1,1,2,2-PCA have significantly increased in monitoring well IR89-MW02 since the Phase I RI sampling event. These detections are shown on Table 1. The compound 1,1,2,2-PCA was not detected within the DRMO during the Phase I RI in 1996, but was first detected at a very high concentration during the April 1999 monitoring program. As described above, this monitoring well was sampled during the Phase I RI, the April 1999 sampling event, and in the June/July immediate response effort. Each detection of VOCs in the three samples obtained from IR89-MW02 exceeded the Federal MCL, the NCWQS, or both (there are no standards established for 1,1,2,2-PCA in groundwater). This increase in concentrations of VOCs suggests an existing source may be present in the vicinity of IR89-MW02. Concentrations of VC, acetone, methylene chloride, cis-1,2-DCE, trans-1,2-DCE, PCE, and TCE have also increased in monitoring well IR89-MW04 located southeast of the DRMO. This monitoring well was only sampled during the Phase II RI, and during the April 1999 sampling event. In each case, all of the detected VOCs (except for acetone) exceeded the Federal MCL, the NCWQS, or both.

Intermediate monitoring wells IR89-MW03IW and IR89-MW04IW were sampled during the Phase II RI and during the April 1999 sampling event. TCE was the main contaminant detected from samples obtained at these two monitoring wells during the Phase II RI. In the April 1999 sampling event, the concentration of TCE did not exhibit an increase in concentration, but additional contaminants were detected, including cis-1,2-DCE and trans-1,2-DCE. The presence of these compounds may suggest natural attenuation processes are occurring in the intermediate aquifer. However, the concentrations exceeded both Federal MCLs and NCWQS.

Monitoring wells IR89-MW08, IR89-MW09, and IR89-MW09IW were installed and sampled during the immediate response effort. Monitoring well IR89-MW08 is located adjacent to a drainage ditch leading from the wash rack area in the eastern portion of the DRMO, discharging to Edwards Creek. Monitoring wells IR89-MW09 and IR89-MW09IW are located in the southern portion of the site adjacent to Edwards Creek. Samples collected at monitoring wells IR89-MW08 and IR89-MW09IW exhibited low concentrations of 1,1,2,2-PCA (120 µg/L and 25 µg/L, respectively). The compound 1,1,2,2-PCA was not detected in the sample collected from IR89-MW09. However, a sample collected from this location showed detections of cis-1,2-DCE, trans-1,2-DCE and TCE at 5,000 µg/L, 1,200 µg/L, and 59,000 µg/L, respectively. These concentrations are above Federal MCLs and NCWQS. Soil samples were collected during the installation of monitoring wells IR89-MW08, IR89-MW09, and IR89-MW09IW. The samples collected from IR89-MW09 and IR89-MW09IW exhibited high concentrations of 1,1,2,2-PCA and TCE. Surface water samples collected during the immediate response effort also detected 1,1,2,2-PCA, TCE, and other chlorinated compounds. These data strongly suggest there are one or more sources of 1,1,2,2-PCA and TCE remaining at the site, which may be contributing to the contamination of Edwards Creek.

Extent of Impact Through Time

Aquifers are part of the hydrologic cycle, continually adjusting to the system of which they are a part. Contaminant plumes are somewhat similar in that they are in a state of flux reacting to physical, chemical, and biological changes within the aquifer. A benefit of having multiple rounds of analytical data at a site affords the capability to evaluate the data over time. This becomes particularly helpful during a hydrologic analysis in light of the fact that several hurricanes have impacted MCB, Camp Lejeune in the past several years. The precipitation events from these storms certainly resulted in above-average recharge to the aquifers.

Figures 4 through 7 have been prepared to summarize changes in VOC contamination observed over time. As shown on Figure 4, VOC concentrations in the shallow aquifer (July/August 1996) have changed compared to that which was observed in April 1999 (Figure 5). Over nearly a three-year period, the impact to the shallow aquifer has changed with higher concentrations of VOCs present in the east central portion of the DRMO. In addition, the plume appears to have migrated to the southeast, being more prevalent at monitoring well cluster IR89-MW04.

Figures 6 and 7 provide a comparison of the intermediate aquifer through the same time period. At this depth, the contaminant plume mimics that of the shallow aquifer; showing increased concentrations to the southeast, but also expanding. The plume in the intermediate aquifer has migrated further to the east, with VOCs being detected at monitoring well cluster IR89-MW06, approximately 1,500 feet from the DRMO area.

Baker

Ms. Katherine H. Landman

November 3, 1999

Page 7

Proposed Sampling Plan

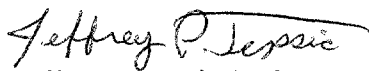
As the data indicate contaminant source(s) exist at Site 89. The installation of monitoring wells with associated soil and groundwater sampling is proposed. Further, additional surface water samples are proposed in order to provide a temporal correlation of concentrations observed in Edwards Creek with concentrations observed in soil and groundwater. The sampling and monitoring well installation plans were presented at the October 5th and 6th, 1999 partnering meeting. Monitoring well installation and sampling was conducted in October 1999. The monitoring well and soil boring locations are provided on Figure 8.

Four shallow groundwater monitoring wells and two intermediate groundwater monitoring wells were installed within and adjacent to the DRMO area. In addition to the groundwater samples collected from the six newly installed monitoring wells, groundwater samples were collected from existing monitoring wells. Soil contamination will be characterized by obtaining soil samples at the intervals shown on Figure 8. Surface water and sediment sampling included collecting 11 surface water and 11 sediment samples. Three samples were collected from the drainage ditch leading to Edwards Creek and the remaining eight surface water/sediment samples were collected from Edwards Creek.

Baker appreciates the opportunity to serve LANTDIV on this important project. If you have any questions or comments regarding the information we have presented in this report, please do not hesitate to contact me at (412) 269-2055 or Ms. Kathy M. Chavara, P. E. at (412) 269-2062.

Sincerely,

BAKER ENVIRONMENTAL, INC.



Jeffrey P. Tepsic, P. G.

Project Manager

cc: One copy each:

Mr. Rick Raines, EMD Camp Lejeune
Mr. David Lown, L.G., P.E., NC DENR – Superfund Section
Ms. Diane Rossi, NC DENR – Groundwater Section
Ms. Gena Townsend, USEPA – Waste Management Division
Mr. Jim Dunn, P. E., OHM Corporation

TABLES

TABLE 1
HISTORIC DATA FOR VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER
FOR SELECT WELLS
OPERABLE UNIT NO. 16 (SITE 89)
MCB CAMP LEJEUNE, NORTH CAROLINA

Well ID	Contaminant	July/Aug 96 Phase I RI (µg/L)	May-97 Phase II RI (µg/L)	Apr-99 LTM (µg/L)	June/July 99 Immediate Response (µg/L)	Federal MCLs (µg/L)	NCWQS (µg/L)
SHALLOW WELLS							
IR89-MW01	trans-1,2-DCE	177	ND	--	--	100	70
	cis-1,2-DCE	261	ND	--	--	70	70
	TCE	323.1	67	--	--	5.0	2.8
	PCE	42.2	4	--	--	5.0	0.7
IR89-MW02	Acetone	ND	--	2,200J	ND	NA	700
	2-Butanone	ND	--	650J	ND	NA	170
	VC	130	--	530J	720	2.0	0.015
	trans-1,2-DCE	451	--	3,800	4,600	100	70
	cis-1,2-DCE	818	--	7,300	8,800	70	70
	TCE	ND	--	7,100	9,200	5.0	2.8
	PCE	9.4	--	ND	130	5.0	0.7
	1,1,2,2-PCA	ND	--	30,000	46,000	NA	NA
IR89-MW02D	VC	--	--	--	690	2	0.015
	trans-1,2-DCE	--	--	--	4,400	100	70
	cis-1,2-DCE	--	--	--	8,900	70	70
	TCE	--	--	--	9,500	5	2.8
	1,1,2-TCA	--	--	--	210	5	NA
	PCE	--	--	--	120	5	0.7
	1,1,2,2-PCA	--	--	--	47,000	NA	NA
IR89-MW03	VC	ND	--	5	--	2.0	0.015
	trans-1,2-DCE	82	--	33	--	100	70
	cis-1,2-DCE	150	--	66	--	70	70
	TCE	131	--	66	--	5.0	2.8
	1,1,2-TCA	ND	--	2J	--	5.0	NA
	PCE	13.1	--	6	--	5.0	0.7
	1,1,2,2-PCA	ND	--	44	--	NA	NA
IR89-MW04	Acetone	--	ND	72	--	NA	700
	Meth. Chloride	--	ND	13J	--	5.0	5.0
	VC	--	43	50	--	2.0	0.015
	trans-1,2-DCE	--	ND	270	--	100	70
	cis-1,2-DCE	--	ND	590	--	70	70
	TCE	--	640	840	--	5.0	2.8
	PCE	--	7	8J	--	5.0	0.7

TABLE 1 (continued)
HISTORIC DATA FOR VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER
FOR SELECT WELLS
OPERABLE UNIT NO. 16 (SITE 89)
MCB CAMP LEJEUNE, NORTH CAROLINA

Well ID	Contaminant	July/Aug 96 Phase I RI (µg/L)	May-97 Phase II RI (µg/L)	Apr-99 LTM (µg/L)	June/July 99 Immediate Response (µg/L)	Federal MCLs (µg/L)	NCWQS (µg/L)
SHALLOW WELLS							
IR89-MW08 ⁽¹⁾	Benzene	--	--	--	0.51	5.0	1.0
	VC	--	--	--	15	2.0	0.015
	trans-1,2-DCE	--	--	--	21	100	70
	cis-1,2-DCE	--	--	--	36	70	70
	TCE	--	--	--	27	5.0	2.8
	PCE	--	--	--	2.7	5.0	0.7
	1,1,2,2-PCA	--	--	--	120	NA	NA
IR89-MW09 ⁽¹⁾	VC	--	--	--	270	2.0	0.015
	trans-1,2-DCE	--	--	--	1,200	100	70
	cis-1,2-DCE	--	--	--	5,000	70	70
	TCE	--	--	--	59,000	5.0	2.8
	PCE	--	--	--	140	5.0	0.7
INTERMEDIATE WELLS							
IR89-MW03IW	Acetone	--	ND	45J	--	NA	700
	Meth.Chloride	--	ND	11J	--	5.0	5.0
	trans-1,2-DCE	--	ND	51	--	100	70
	cis-1,2-DCE	--	ND	220	--	70	70
	TCE	--	400	1310	--	5.0	2.8
IR89-MW04IW	Acetone	--	ND	55	--	NA	700
	Meth. Chloride	--	ND	14J	--	5.0	5.0
	trans-1,2-DCE	--	ND	93	--	100	70
	cis-1,2-DCE	--	ND	400	--	70	70
	TCE	--	510	1890	--	5.0	2.8
IR89-MW09IW ⁽¹⁾	VC	--	--	--	--	2.0	0.015
	Acetone	--	--	--	12J	NA	700
	trans-1,2-DCE	--	--	--	7.8	100	70
	cis-1,2-DCE	--	--	--	26	70	70
	TCE	--	--	--	200	5.0	2.8
	1,1,2,2-PCA	--	--	--	25	NA	NA

Notes:

Indicates an exceedence of Federal MCL or NCWQS.

Concentrations are in micrograms per liter.

J = Estimated Value

NA = Not Applicable - no standard available.

ND = Not Detected

-- = Not Sampled.

(1) This monitoring well was installed for the June/July Immediate Response Effort.

TABLE 2
HISTORIC DATA FOR VOLATILE ORGANIC COMPOUNDS IN SURFACE WATER
OPERABLE UNIT NO. 16 (SITE 89)
MCB CAMP LEJEUNE, NORTH CAROLINA

Sample ID	Contaminant	July-Aug-96 Phase I RI (µg/L)	April 1999 LTM (µg/L)	June/July 99 Immediate Response (µg/L)	AWQS (µg/L)	NCWQS (µg/L)
IR89-SW01	Chloroform	0.3*	--	--	5.7	NA
	cis-1,2-DCE	2*	--	--	NA	NA
	TCE	3.8*/(31)	--	--	2.7	92.4
	PCE	0.2*	--	--	0.8	NA
IR89-SW02	Chloroform	0.2*	--	--	5.7	NA
	VC	(25)	--	--	2.0	525
	trans-1,2-DCE	37*	--	--	NA	NA
	cis-1,2-DCE	48*	--	--	NA	NA
	1,2-DCE (total)	(120)	--	--	NA	NA
	TCE	7.3*/(18)	--	--	2.7	92.4
	PCE	0.2*	--	--	0.8	NA
	1,1,2,2-PCA	(150)	--	--	0.17	10.8
IR89-SW03	Benzene	ND	--	5.7	1.2	71.4
	Chlorobenzene	ND	--	5.9	680	NA
	Chloroform	0.1*	--	ND	5.7	NA
	Toluene	ND	--	6.2	6800	NA
	VC	(21)	--	27	2.0	525
	trans-1,2-DCE	31*	--	28	NA	NA
	cis-1,2-DCE	44*	--	42	NA	NA
	1,2-DCE (total)	(100)	--	ND	NA	NA
	1,1-DCE	ND	--	74	0.057	NA
	TCE	6.4*/(16)	--	8.8	2.7	92.4
	PCE	0.2*	--	ND	0.8	NA
	1,1,2,2-PCA	(130)	--	15	0.17	10.8
IR89-SW04	Acetone	ND	6J	6.4J	NA	NA
	Chloroform	0.4*	ND	ND	5.7	NA
	VC	ND	16	24	2.0	525
	trans-1,2-DCE	19*	18	35	NA	NA
	cis-1,2-DCE	52*	56	110	NA	NA
	1,2-DCE (total)	(78)	ND	ND	NA	NA
	1,1-DCE	ND	ND	1.2	0.057	NA
	TCE	32.9*/(26)	40	130	2.7	92.4
	1,1,2-TCA	ND	17	2.7	0.6	NA
	PCE	0.2*	ND	ND	0.8	NA
	1,1,2,2-PCA	(72)	44	84	0.17	10.8

TABLE 2 (continued)
HISTORIC DATA FOR VOLATILE ORGANIC COMPOUNDS IN SURFACE WATER
OPERABLE UNIT NO. 16 (SITE 89)
MCB CAMP LEJEUNE, NORTH CAROLINA

Sample ID	Contaminant	July-Aug-96 Phase I RI (µg/L)	April 1999 LTM (µg/L)	June/July 99 Immediate Response (µg/L)	AWQS (µg/L)	NCWQS (µg/L)
IR89-SW05	Chloroform	0.3*	--	--	5.7	NA
	trans-1,2-DCE	15*	--	--	NA	NA
	cis-1,2-DCE	44*	--	--	NA	NA
	1,2-DCE (total)	(78)	--	--	NA	NA
	TCE	27.3*/(24)	--	--	2.7	92.4
	PCE	0.1*	--	--	0.8	NA
	1,1,2,2-PCA	(80)	--	--	0.17	10.8
IR89-SW06	TCE	--	2J	--	2.7	92.4
	1,1,2,2-PCA	--	2J	--	0.17	10.8
IR89-SW07	Acetone	ND	8J	--	NA	NA
	cis-1,2-DCE	27*	ND	--	NA	NA
	trans-1,2-DCE	21*	ND	--	NA	NA
	TCE	14.8*	2J	--	2.7	92.4
	PCE	1.2*	ND	--	0.8	NA
	1,1,2,2-PCA	ND	3J	--	0.17	10.8
IR89-SW08	PCE	0.4*	--	--	0.8	NA
IR89-SW09	Chloroform	0.4*	--	--	5.7	NA
	trans-1,2-DCE	16*	--	--	NA	NA
	cis-1,2-DCE	44*	--	--	NA	NA
	TCE	28.5*	--	--	2.7	92.4
	PCE	0.2*	--	--	0.8	NA
IR89-SW10	Chloroform	0.4*	--	--	5.7	NA
	trans-1,2-DCE	15*	--	--	NA	NA
	cis-1,2-DCE	43*	--	--	NA	NA
	TCE	27.9*	--	--	2.7	92.4
	PCE	0.1*	--	--	0.8	NA
IR89-SW11	Acetone	ND	ND	13J	NA	NA
	Methylene Chloride	27.6*	2J	ND	NA	NA
	VC	0.4*	32	24	2.0	525
	trans-1,2-DCE	14*	45	36	NA	NA
	cis-1,2-DCE	43*	140	110	NA	NA
	TCE	27.6*	97	130	2.7	92.4
	1,1,2-TCA	ND	3J	2.7	0.6	NA
	PCE	0.2*	ND	ND	0.8	NA
	1,1,2,2-PCA	ND	120	78	0.17	10.8

Notes:

Indicates an exceedence of Federal AWQS or NCWQS.

Concentrations are in micrograms per liter.

NA = Not Applicable - no standard available.

ND = Not Detected.

* = August 1996 Phase I RI mobile lab data

() = Fixed base analysis from Phase I RI

-- = Not Sampled.

TABLE 3
POSITIVE DETECTIONS FOR VOLATILE ORGANIC COMPOUNDS IN SOIL
JUNE/JULY 1999
OPERABLE UNI NO. 16 (SITE 89)
MCB CAMP LEJEUNE, NORTH CAROLINA

Sample ID	Contaminant	June/July 99 Immediate Response (µg/kg)	RBCs		Site-Specific Soil to Groundwater Transfer SSLs (µg/kg)
			Industrial (µg/kg)	Residential (µg/kg)	
IR89-MW08-01	Acetone	80J	204,400,000	7,821,429	2834
IR89-MW08-02	Acetone	5,900	204,400,000	7,821,429	2834
	1,1,2,2-PCA	15J	28,616	3,194	7
	Xylene (total)	26J	4,088,000,000	156,428,571	12494
IR89-MW09-01	trans-1,2-DCE	62	40,880	1,564.3	540
	cis-1,2-DCE	220	20,440,000	3,821,443	499
	TCE	1,000	520,291	58,066	34
	1,1,2-TCA	160	100.4	11.2	50
	1,1,2,2-PCA	29,000	28,616	3,194	7
IR89-MW09-02	trans-1,2-DCE	670	40,880	1,564.3	540
	cis-1,2-DCE	2,400	20,440,000	3,821,443	499
	TCE	2,000	520,291	58,066	34
	1,1,2-TCA	130J	100.4	11.2	50
	PCE	360	110.1	12.3	19
	1,1,2,2-PCA	27,000	28,616	3,194	7
IR89-MW09-02D	trans-1,2-DCE	530	40,880	1,564.3	540
	cis-1,2-DCE	1,800	20,440,000	7,821,443	499
	TCE	1,200	520,291	58,066	34
	PCE	280	110.1	12.3	19
	1,1,2,2-PCA	26,000	28,616	3,194	7

Notes:

- 1) Indicates an exceedence of Federal industrial or residential RBC or a site specific soil screening level.
- 2) Concentrations are in micrograms per kilogram.
- 3) Site-specific soil screening values are calculated using the USEPA soil screening guidance for organics. Note that there is no guidance for 1,1,2,2-PCA. Therefore, the input value for PCE was used. If the Region III tap water RBC for 1,1,2,2-PCA had been used in the calculation, the soil to groundwater transfer SSL would have been 1 micrograms/kilogram.

TABLE 4
USEPA SOIL SCREENING GUIDANCE
CALCULATION OF SITE-SPECIFIC
SOIL SCREENING LEVELS FOR ORGANICS
OPERABLE UNIT NO. 16 (SITE 89)
MCB CAMP LEJEUNE, NORTH CAROLINA

Equation: $C_{\text{soil}} = C_{\text{GW}} \cdot \left[\frac{K_{oc} + (n_w + n_a H)}{P_b} \right]^{df}$

Soil Screening Levels (ug/kg)	
1,1,2,2-tetrachloroethane	7
1,1,2-trichloroethane	50
cis-1,2-dichloroethene	499
trans-1,2-dichloroethene	540
tetrachloroethene	19
trichloroethene	34
acetone	2834
xylene (total)	12494

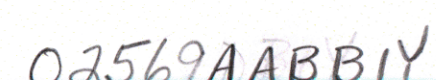
Calculation Input Table			
Definition	Units	Value	Source
C_{soil} - Calculated soil concentration for soil	mg/kg	--	Calculated
C_{GW} - Applicable groundwater target concentration	mg/L		
1,1,2,2-tetrachloroethane (none; see value for PCE)		0.0007	NC 2L Standard
1,1,2-trichloroethane		0.005	Federal MCL
cis-1,2-dichloroethene		0.07	NC 2L Standard
trans-1,2-dichloroethene		0.07	NC 2L Standard
tetrachloroethene		0.0007	NC 2L Standard
trichloroethene		0.0028	NC 2L Standard
acetone		0.7	NC 2L Standard
xylene (total)		0.53	NC 2L Standard
df - Dilution Factor	unitless	20	USEPA, 1996
K_s - Soil-water partition coefficient	L/kg	$K_s = K_{oc} \times f_{oc}$	--
1,1,2,2-tetrachloroethane		0.316	
1,1,2-trichloroethane		0.3	
cis-1,2-dichloroethene		0.142	
trans-1,2-dichloroethene		0.152	
tetrachloroethene		1.06	
trichloroethene		0.3772	
acetone		0.0023	
xylene (total)		0.96	
K_{oc} - Soil organic carbon-water partition coefficient	L/kg		
1,1,2,2-tetrachloroethane		79	USEPA, 1996
1,1,2-trichloroethane		75	USEPA, 1996
cis-1,2-dichloroethene		35.5	USEPA, 1996
trans-1,2-dichloroethene		38	USEPA, 1996
tetrachloroethene		265	USEPA, 1996
trichloroethene		94.3	USEPA, 1996
acetone		0.575	USEPA, 1996
xylene (total)		240	USEPA, 1996
f_{oc} - Fraction organic carbon in vadose zone soil	$E_{\text{carbon}}/E_{\text{soil}}$	0.004	Base-specific value ⁽¹⁾
n_w - Water filled soil porosity (vadose zone soil)	$L_{\text{water}}/L_{\text{soil}}$	0.3	USEPA, 1996
n_a - Air filled soil porosity (vadose zone soil)	$L_{\text{air}}/L_{\text{soil}}$	0.13	USEPA, 1996
H' - Henry's Law Constant	unitless		
1,1,2,2-tetrachloroethane		0.01558	USEPA, 1996
1,1,2-trichloroethane		0.03731	MA Dept. of Env. Protection, 1994
cis-1,2-dichloroethene		0.167	USEPA, 1996
trans-1,2-dichloroethene		0.385	USEPA, 1996
tetrachloroethene		0.754	USEPA, 1996
trichloroethene		0.37392	USEPA, 1996
acetone		1.59E-03	USEPA, 1996
xylene (total)		2.16E-01	MA Dept. of Env. Protection, 1994
P_b - Bulk Density	kg/L	1.5	USEPA, 1996

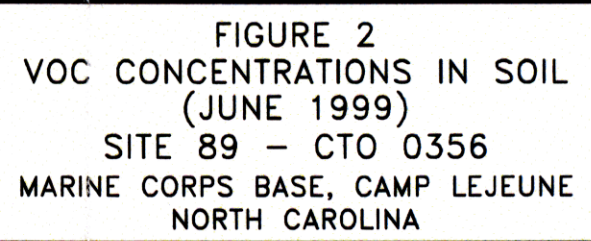
Note: USEPA, 1996. Soil Screening Guidance: Technical Background Document. EPA/540/R-95/128. May 1996.

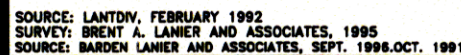
Massachusetts Department of Environmental Protection, 1994. Background documentation for the development of the MCP numerical standards.

⁽¹⁾ f_{oc} value used in these calculations is based on average of f_{oc} values obtained from Site 88 and Site 36 at MCB, Camp Lejeune.

FIGURES







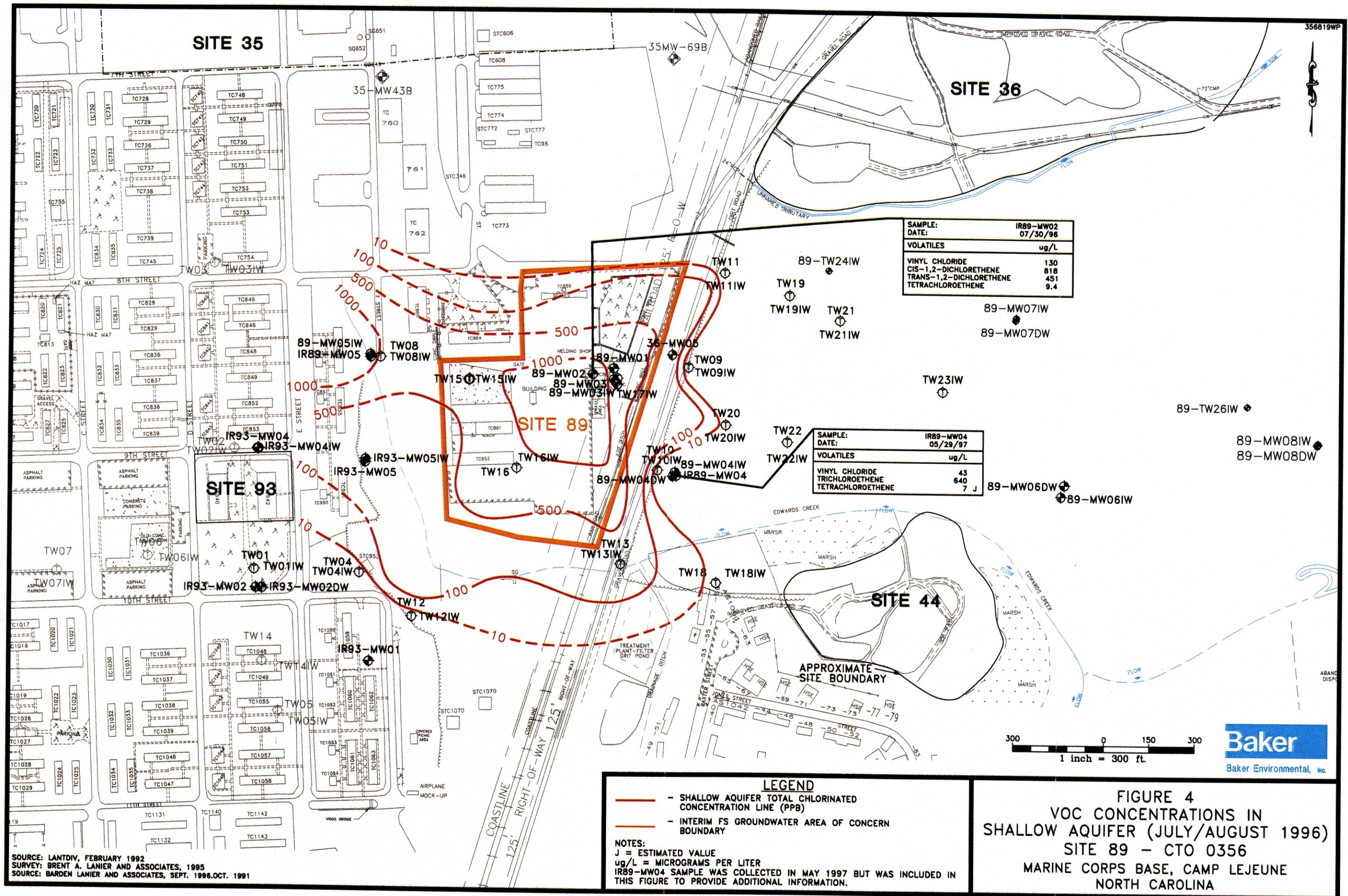
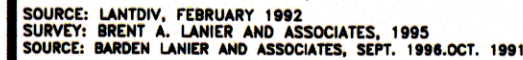
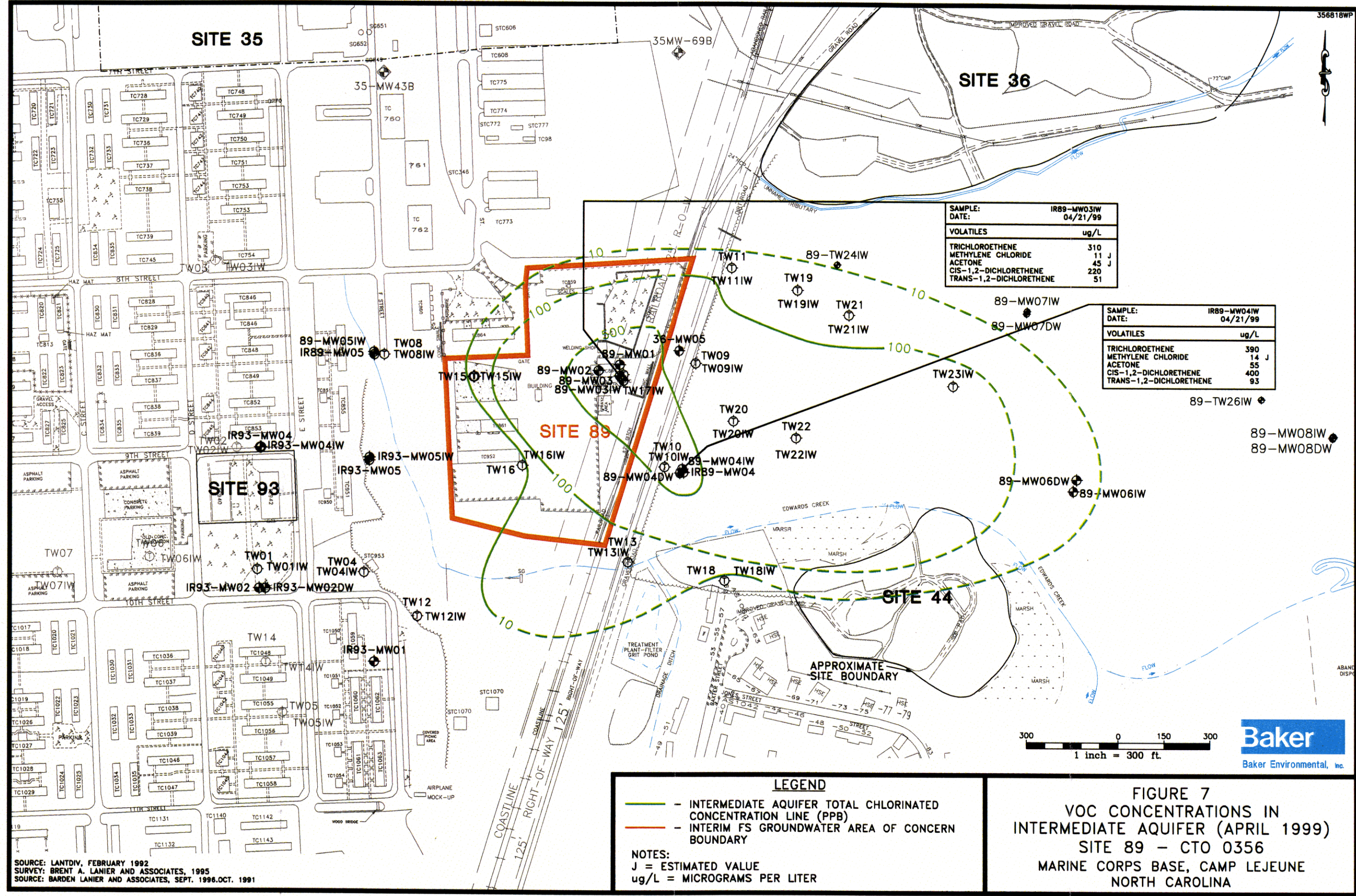
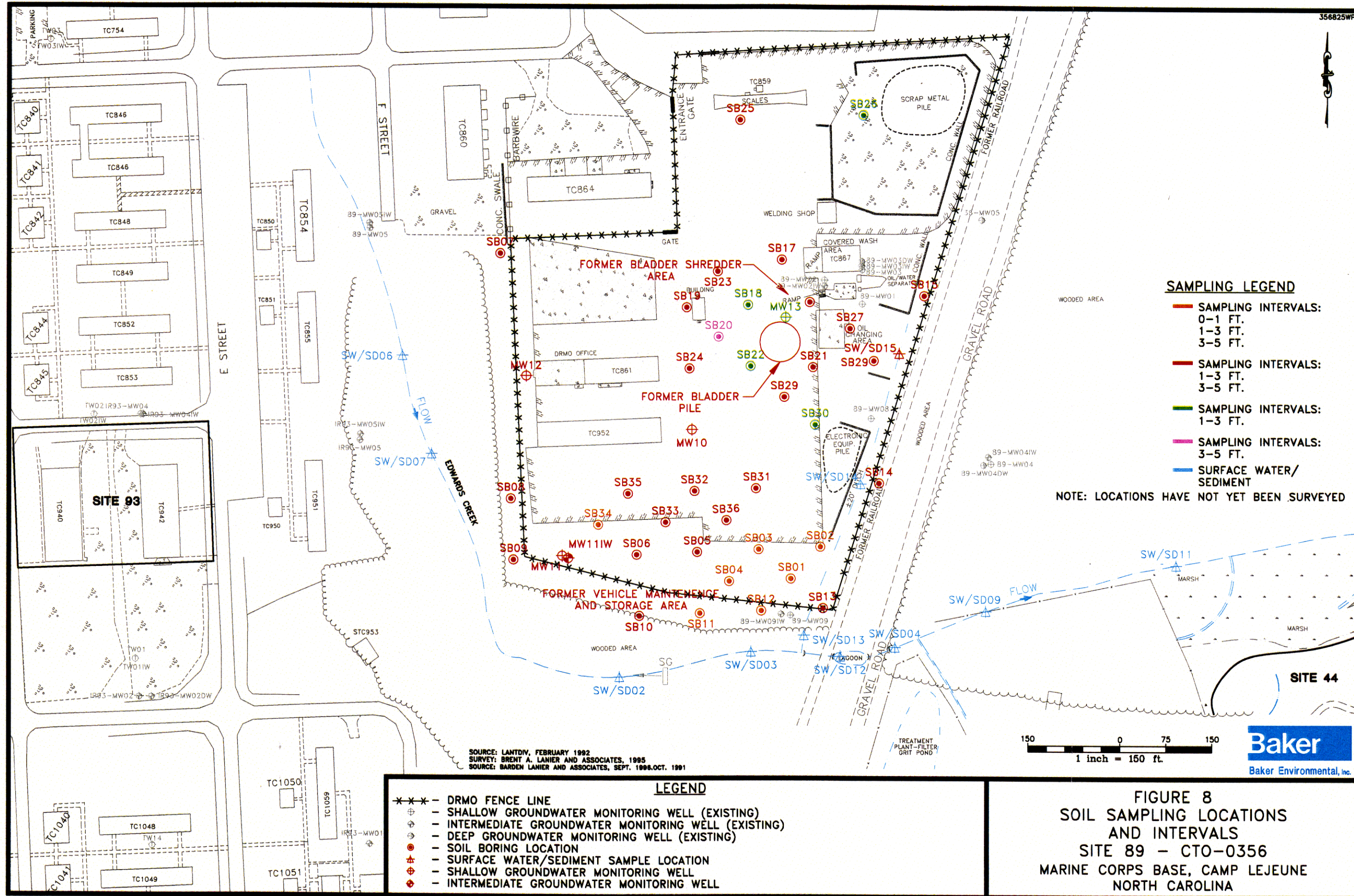




FIGURE 5
VOC CONCENTRATIONS IN
SHALLOW AQUIFER (APRIL 1999)
SITE 89 - CTO 0356
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA







ATTACHMENT A

**JULY 1999 FIELD INVESTIGATION PHOTOGRAPHS
OPERABLE UNIT NO. 16, SITE 89
MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA**



Looking at base of Covered Wash Area, Rip-rap area located over former UST area.



Looking West, Standing adjacent to southern DRMO fence while installing Monitoring Well Cluster IR89MW09.

02569A ABB2Y



Looking North within the DRMO, standing immediately adjacent to Oil Changing Area



Looking Southeast at Covered Wash Area, standing adjacent to IR89-MW02

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FIGURE NO.: Photos 2p95

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Z = B & W 11 X 17

Y = COLOR

X = OVERSIZE